FILE COPY

U.S. Department of Energy

Oakland Operations Office, Oakland, California

RECORD COPY
PROJECT: 17823
CAT. T3.9.2.9

DESIGNATED-LEVEL SAMPLING AND ANALYSIS PLAN ADDENDUM FOR THE DOE DISPOSAL BOX AREA

at the

LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH UNIVERSITY OF CALIFORNIA, DAVIS

Prepared for:

United States Department of Energy, National Nuclear Security Administration
Oakland Operations Office
1301 Clay Street
Oakland, California 94612-5208

Prepared by:

Weiss Associates
5801 Christie Avenue, Suite 600
Emeryville, California 94608

November 1, 2002
Rev. 0

DOE Oakland Operations Contract DE-AC03-96SF20686

Weiss Associates
Environmental and Geologic Services

DESIGNATED-LEVEL SAMPLING AND ANALYSIS PLAN ADDENDUM FOR THE DOE DISPOSAL BOX AREA

at the

LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH UNIVERSITY OF CALIFORNIA, DAVIS

Prepared for:

United States Department of Energy, National Nuclear Security Administration
Oakland Operations Office
1301 Clay Street
Oakland, California 94612-5208

Prepared by:

Weiss Associates
5801 Christie Avenue, Suite 600
Emeryville, California 94608

November 1, 2002
Rev. 0

DOE Oakland Operations Contract DE-AC03-965F20686

Issued To: _____ Date: _____

Copy No.: _____ ☐ Controlled ■ Uncontrolled

Approvals Page

DESIGNATED-LEVEL SAMPLING AND ANALYSIS PLAN ADDENDUM FOR THE DOE DISPOSAL BOX AREA

at the

LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH UNIVERSITY OF CALIFORNIA, DAVIS

Submitted to:

U.S. Department of Energy, National Nuclear Security Administration
Oakland Operation Office
1301 Clay Street
Oakland, California 94612-5208

Prepared by:

Weiss Associates
5801 Christie Avenue, Suite 600
Emeryville, California 94608-1827

November 1, 2002
Rev. 0

Approved by: _____ Date: 11/4/02
Dolores D. Loll, P.E.
Project Quality Assurance Manager
Weiss Associates

Approved by: _____ Date: 11/4/02
Robert O. Devany, R.G., C.E.G., C.H.G.
Project Manager
Weiss Associates

Approved by: _____ Date: 11-4-02
Michael D. Dresen, R.G., C.E.G., C.H.G.
Program Manager
Weiss Associates

CONTENTS

1. SAMPLING AND ANALYSIS 1-1

1.1 Data Quality Objectives 1-1

1.1.1 Statement of the Problem 1-1

1.1.2 Identification of Decisions 1-2

1.1.3 Identification of Decision Inputs 1-2

1.1.4 Definition of Study Boundaries 1-2

1.1.5 Development of Decision Rules 1-3

1.1.6 Specification of Limits on Decision Errors 1-3

1.1.7 Sample Design Optimization 1-3

1.2 Analytical Plan 1-5

2. REFERENCES 2-1

TABLES

Table 1. Summary of DOE Disposal Box Area Designated-Level Sampling and Analysis

Table 2. Containers, Laboratory Analytical Methods, Detection Limits and Holding Times for DOE Disposal Box Area Designated-Level Soil Sampling

Table 3. Laboratory Analytical Methods, Detection Limits and Holding Times for Designated-Level Grab Ground Water Samples

Table A-1. Preliminary DOE Disposal Box Area Designated-Level Analysis

FIGURES

Figure 1. DOE Disposal Box Area Designated-Level Sample Locations

Figure A-1. Preliminary Designated-Level Analysis Flow Chart

APPENDIX

Appendix A. Preliminary DOE Disposal Box Area Designated Level Analysis

ACRONYMS

Am-241	americium-241
bgs	below ground surface
CLP	Contract Laboratory Program
COC	constituent of concern
Cr^{+6}	hexavalent chromium
DI WET	waste extraction test using de-ionized water
DL	designated-level
DOE	United States Department of Energy
DPs	daughter productions
DQO	data quality objective
ea.	each
ft	feet
G	glass
ID	identification (number)
ILM	Inorganic Laboratory Method
K_d	soil adsorption coefficient
l	liter
LEHR	Laboratory for Energy-Related Health Research
mg/kg	milligram(s) per kilogram
ml/g	milliliter(s) per gram
OAK	Oakland Operation Office
OLM	Organic Laboratory Method
oz.	ounce
PCBs	polychlorinated biphenyls
pCi/g	picoCurie(s) per gram
pCi/l	picoCurie(s) per liter
SAP	sampling and analysis plan

SOP	standard operating procedure
SOW	statement of work
SVOC	semi-volatile organic compound
TAT	turnaround time
US EPA	United States Environmental Protection Agency
U-235/236	uranium-235/236
VOA	volatile organic analysis
VOC	volatile organic compound
WA	Weiss Associates
WRS	wilcoxon rank sum
µg/l	microgram per liter

1. SAMPLING AND ANALYSIS

This sampling and analysis plan (SAP) is an addendum to the *Final Sampling and Analysis Plan for DOE Disposal Box Area Confirmation Data Gaps* (Weiss Associates [WA], 2002). This SAP presents the approach and procedures for designated-level (DL) sampling and analysis in the Department of Energy (DOE) Box Disposal Area (Figure 1) at the Laboratory for Energy-Related Health Research (LEHR), University of California, Davis (UC Davis). The objective of this sampling and subsequent data evaluation is to determine whether residual concentrations of specific constituents in soil could potentially impact ground water. In addition, this SAP includes data quality objectives (DQOs) for the sampling activities and procedures for field work.

The preliminary DL evaluation (Appendix A) conducted on the DOE Box Area identified that hexavalent chromium (Cr^{+6}), mercury, molybdenum and uranium-235/236 (U-235/236) require additional evaluation. This SAP is designed to delineate the vertical extent of contamination of the identified DL constituents of concern (COCs) in the DOE Disposal Box Area.

1.1 Data Quality Objectives

This SAP was developed using the DQO process described in *Guidance for the Data Quality Objectives Process* (US EPA document number QA/G-4) and *Data Quality Objectives Process for Superfund* (United States Environmental Protection Agency [US EPA] document number EPA540-R-93-071). The DQO process is a systematic planning tool for establishing criteria for data quality and for designing data collection plans. The following sections demonstrate how the seven steps of the US EPA DQO process were used in designing the DL SAP.

1.1.1 Statement of the Problem

Under the Federal Facility Agreement between the DOE and the US EPA, DOE is the lead agency for cleanup of soil contamination associated with LEHR-related activities. The DOE-Oakland Operations Office (OAK) will make the final decisions on all activities associated with the DOE Disposal Box Area DL sampling based on recommendations from the planning team in accordance with the terms of the Federal Facility Agreement, and all applicable orders, statutes and regulations. The planning team consists of DOE-OAK; Remedial Project Managers from US EPA Region IX, the California Department of Toxic Substances Control, the Central Valley Regional Water Quality Control Board, and the California Department of Health Services; UC Davis; the Davis South Campus Superfund Oversight Committee; and WA and its subcontractors, Shaw Environmental and Infrastructure, Inc. and Environmental Management Services.

The fundamental question to be answered by this sampling and analysis program is: "Will the post-removal action residual concentrations of specific constituents in soil at the DOE Disposal Box Area potentially impact ground water?" The sampling program described subsequently is designed to provide DOE-OAK and the planning team with the data needed to delineate the vertical extent of DL COCs in the DOE Disposal Box Area.

1.1.2 Identification of Decisions

The decision statement for the DL sampling is:

- Determine whether or not residual concentrations of specific metals and radionuclides in the vadose zone beneath the DOE Disposal Box Area could potentially impact the underlying groundwater.

1.1.3 Identification of Decision Inputs

Existing data that will be used to resolve the decision statement include data collected during the 1996 DOE Disposal Box Area removal action confirmation sampling and the 2002 DOE Disposal Box Area confirmation data gaps sampling. New environmental measurement input will include:

- Soil sampling at appropriate locations and depths;
- Continuous soil sample description using the Unified Soil Classification System;
- Laboratory analyses for DL COCs; and,
- Laboratory data validation.

1.1.4 Definition of Study Boundaries

The geographical area addressed in this SAP consists of the sample locations shown on Figures 1 and 2. The sampling and analysis program is limited to the DL COCs identified by the preliminary DL analysis of the DOE Disposal Box Area data (Appendix A.)

1.1.5 Development of Decision Rules

The primary decision rules for the DL sampling are:

- If the residual DL COC concentrations at the DOE Disposal Box Area will potentially impact ground water above site background thresholds, then remedial action and/or long term monitoring may be recommended in the DOE Areas Feasibility Study.

- Alternatively, if the metals and radionuclide concentrations at the DOE Disposal Box Area will not impact ground water above site background thresholds, then no additional remedial action may be recommended in the DOE Areas Feasibility Study.

1.1.6 Specification of Limits on Decision Errors

Since, the DL sampling data will not be used for statistical analyses, this step of the DQO process does not apply.

1.1.7 Sample Design Optimization

This section describes the location and number of samples that will be collected to evaluate potential impact to ground water by the DL COCs. The output from each of the first six DQO steps described in Sections 1.1.1 through 1.1.6 were used to optimize the sampling and analysis program. Samples will be collected from DL boring DB-DL1 (Figure 2) at the location of sample SSDBC009/010 and analyzed for mercury, molybdenum and Cr^{+6}. Sample SSDBC009/010 had the second highest mercury concentration in the DOE Disposal Box Area, 2.6 milligrams per kilogram (mg/kg), and the third highest concentration of Cr^{+6}, 0.446 mg/kg. No molybdenum data was collected from this location, however the second highest molybdenum concentration, 0.53 mg/kg, was detected in a sample collected approximately five feet north of sample location SSDBC009/010. The mercury, molybdenum and Cr^{+6} data show no concentration distribution trends that indicate a release of contamination. Therefore, sampling for these metals from one boring location is justified. Sample SSDBC035 had the highest U-235/236 concentration, 0.074 picoCuries per gram. Therefore, DL boring, DB-DL2 (Figure 2) will be drilled at sample location SSDBC035.

Soil samples will be collected from each DL boring at five-ft intervals for DL COCs, with the first sample collected approximately five ft below the depth of the original sample (Table 1). Sample collection will continue to approximately 35 ft below ground surface (bgs).

A ground water sample will be collected from each boring when ground water is encountered if an adequate volume of ground water is reasonably obtainable. The ground water sample will be analyzed for metals, radionuclides, semi-volatile organic compounds, volatile organic compounds,

pesticides, nitrate, and Cr^{+6}. Ground water samples will require filtering prior to analysis for metals, nitrate, Cr^{+6}, and radionuclides except for tritium and carbon-14. Ground water will be filtered in the field using a disposable 0.45-micron filter. Ground water samples collected for all other analyses will not be filtered.

In addition, the first two soil samples collected from boring DB-DL1 will be analyzed for mercury, molybdenum and hexavalent chromium using the waste extraction test with de-ionized water (DI WET). The DI WET samples will be collected based on a comment made by the California Regional Water Quality Control Board on a previously submitted work plan. The DI WET results will be used to calibrate the vadose zone modeling results.

1.1.7.1 Field Sampling Procedures

DL borings will be located using survey coordinates and will be continuously cored using a direct-push drill rig. Soil samples will be collected in a core barrel with a butyrate liner. The soil cores will be screened by the Field Geologist for visual indications of contamination. The Field Geologist will use the Unified Soil Classification System to describe and document the lithology of the soil cores. The samples will be given unique identification numbers and placed in a cooler for transport to the laboratory under chain-of-custody procedures. In addition, at least one duplicate sample will be collected for every 10 samples (10%) for quality control.

All downhole drilling equipment will be steam-cleaned prior to arrival on site, and will be cleaned between each borehole using an Alconox detergent-water wash, a potable water rinse, and a final de-ionized water rinse. Investigation-derived waste, consisting of decontamination water and unused soil core, will be combined for proper disposal with another appropriate site waste stream, as determined by the LEHR Waste Coordinator. Upon completion of the field work, all borings will be grouted to the surface with a cement grout containing 3-5% bentonite by weight.

Soil sampling will be conducted in accordance with applicable standard operating procedures listed in the *Final Sampling and Analysis Plan for DOE Disposal Box Area Confirmation Data Gaps* (WA, 2002).

Conditions that may cause deviation from this planned sampling and analysis include:

- Physical obstructions that prevent sampling in selected locations;
- Field screening measurements indicating that the work environment, or some aspect of it, is unsafe for human or environmental health and/or welfare;
- Equipment required to perform the intended work safely is unavailable; and,
- Ground water encountered shallower than 35 ft bgs.

All of these conditions are considered very unlikely. However, if one or more of them occur, potential impact on achieving DQOs will be evaluated and addressed, and modifications to the sampling will be considered.

1.1.7.2 Sample Numbers

The sample matrix will be identified by "SS" for soil sample or "WS" for water sample. The sample collection area will be identified as: "DB" for Disposal Box. Since these are DL samples, they will be identified by "DL." Samples will be numbered sequentially. For example, the first DL soil sample collected from the DOE Disposal Box Area will be identified as SSDBDL01.

1.2 Analytical Plan

The soil and water sample containers, laboratory and water sample analytical methods, detection limits, and holding times are specified in Tables 2 and 3. Analyses will be performed on a standard 30-day turnaround time for metals and a 45-day turnaround time for radionuclides.

The samples collected for this investigation will be analyzed by General Engineering Laboratories, Inc. in Charleston, South Carolina. Laboratory reports (hard copies and electronic files) will be forwarded from the laboratory to the Project Chemist. These results will be validated and transferred to the project database by the WA Database Manager in accordance with procedures described in the Quality Assurance Project Plan (WA, 2000).

2. REFERENCES

United States Environmental Protection Agency (US EPA), 1993, Data Quality Objectives Process for Superfund, Interim Final Guidance, document number EPA540-R-93-071.

US EPA, 2000, Guidance for the Data Quality Objectives Process, document number EPA600-R-96-055.

Weiss Associates (WA), 2000, Final Quality Assurance Project Plan for the Laboratory for Energy-Related Health Research, University of California, Davis, June, Rev. 3.

WA, 2002, Final Sampling and Analysis Plan for DOE Disposal Box Area Confirmation Data Gaps at the Laboratory for Energy-Related Health Research, University of California, Davis, April 1, Rev. 0.

TABLES

Table 1. Summary of DOE Disposal Box Area Designated-Level Sampling and Analysis

DL COC	Sample ID	Original Sample Depth (ft bgs)	DL COC Boring ID	Sample Depths (ft bgs) [1]	Total Samples	Assumptions
Hexavalent chromium, mercury, molybdenum	SSDBC009/010	10	DB-DL1	15, 20, 25, 30, 35	6	Soil samples will be collected at five-ft intervals; one field duplicate will be collected
DI WET for metals for hexavalent chromium, mercury, molybdenum			DB-DL1	15, 20	2	First two samples collected at boring location
Metals, radiological, VOCs, SVOCs, pesticides, nitrate, hexavalent chromium			DB-DL1	Water table	1	Open bore hole ground water sample at water table
Uranium-235/236	SSDBC035	5.5	DB-DL2	10.5, 15.5, 20.5, 25.5, 30.5, 35.5	7	Soil samples will be collected at five-ft intervals; one field duplicate will be collected
Metals, radiological, VOCs, SVOCs, pesticides, nitrate, hexavalent chromium			DB-DL2	water table	1	Open borehole water sample at water table

Notes
[1] Samples will be collected in each boring at the depths indicated.

Abbreviations

bgs	below ground surface
COC	constituent of concern
DI WET	waste extraction test using deionized water
DL	designated-level
ft	feet
ID	identification (number)
SVOCs	semi-volatile organic compounds
VOCs	volatile organic compounds

Table 2. Containers, Laboratory Analytical Methods, Detection Limits and Holding Times for DOE Disposal Box Area Designated-Level Soil Sampling

Parameter/Container	Analytical Method	Required Detection Limit (pCi/g for radionuclides, mg/kg for metals/general chemistry)	Holding Time
Radionuclides (2 ea. 16-oz G):			
Uranium-235/236	Lab SOP	0.01	6 months
Metals (2 ea. 4-oz G):	CLP SOW ILM 04.0		
Mercury		0.1	28 days
Molybdenum		0.1	6 months
General Chemistry (4-oz G)			
Hexavalent Chromium	SW-846 Method 3060A/7196	0.05	24 hours

Abbreviations

CLP SOW	Contract Laboratory Program Statement of Work
COC	constituent of concern
ea.	each
G	glass
ILM 4.0	Inorganic Laboratory Method 4.0
mg/kg	milligrams per kilogram
oz	ounce
pCi/g	picoCuries per gram
SOP	Standard Operating Procedure

Table 3. Laboratory Analytical Methods, Detection Limits and Holding Times for Designated-Level Ground Water Samples

Parameter/Container	Analytical Method	Required Detection Limit (pCi/l for radiochemicals, mg/l for metals/general chemistry, µg/l for organics)	Holding Time
Laboratory Analyses			
Radionuclides (4 ea. 1-L Poly and 2 ea. 2-L Poly):			
Americium-241	Lab SOP	15	6 months
Carbon-14	Lab SOP	50	6 months
Gamma Emitters	Lab SOP	50	6 months
Actinium-228	Lab SOP	50	6 months
Bismuth-212	Lab SOP	50	6 months
Bismuth-214	Lab SOP	50	6 months
Cesium-137	Lab SOP	50	6 months
Cobalt-60	Lab SOP	50	6 months
Lead-210	Lab SOP	50	6 months
Lead-212	Lab SOP	50	6 months
Lead-214	Lab SOP	50	6 months
Potassium-40	Lab SOP	50	6 months
Radium-223	Lab SOP	50	6 months
Radium-228	Lab SOP	10	6 months
Radium-226 (*)	Lab SOP	10	6 months
Thallium-208	Lab SOP	50	6 months
Thorium-228	Lab SOP	50	6 months
Thorium-230	Lab SOP	50	6 months
Thorium-232	Lab SOP	50	6 months
Thorium-234	Lab SOP	50	6 months
Gross Alpha	EPA Method 900.0	3	6 months
Gross Beta	EPA Method 900.0	10	6 months
Plutonium-241	Lab SOP	50	6 months
Strontium-90	EPA Method 905.0	2	6 months
Tritium	EPA Method 906.0	4,000	6 months
Uranium-233/234	Lab SOP	4	6 months
Uranium-235	Lab SOP	4	6 months
Uranium-238	Lab SOP	4	6 months

Table 3. Laboratory Analytical Methods, Detection Limits and Holding Times for Designated-Level Grab Ground Water Samples (continued)

Parameter/Container	Analytical Method	Required Detection Limit (pCi/l for radiochemicals, mg/l for metals/general chemistry, µg/l for organics)	Holding Time
Metals (1-L Poly):	CLP SOW ILM 04.0		
Antimony		0.001	6 months
Arsenic		0.01	6 months
Barium		0.2	6 months
Beryllium		0.001	6 months
Cadmium		0.001	6 months
Chromium (total)	CLP SOW ILM 04.0	0.01	6 months
Cobalt		1	6 months
Copper		0.2	6 months
Iron		1	6 months
Lead		0.003	6 months
Manganese		1	6 months
Mercury		0.0004	28 days
Molybdenum		1	6 months
Nickel		0.02	6 months
Selenium		0.01	6 months
Silver		0.02	6 months
Thallium		0.0004	6 months
Vandium		1	6 months
Zinc		1	6 months
General Chemistry (1L Poly)			
Hexavalent Chromium	SW-846 Method 3060A/7196	0.1	24 hours
Nitrate	EPA Method 300.0	10	48 days
Organics:			
Volatile Organic Compounds (3 ea. VOA G vials)	CLP SOW OLM 4.2	Exhibit C of SOW OLM 4.2	14 days
Semi-Volatile Organic Compounds (2 ea. 1-l Amber G)	CLP SOW OLM 4.2	Exhibit C of SOW OLM 4.2	7 days to extraction, 40 days to analysis of extract
Pesticides/PCBs (2 ea. 1-l Amber G)	CLP SOW OLM 4.2	Exhibit C of SOW OLM 4.2	7 days to extraction, 40 days to analysis of extract

Table 3. Laboratory Analytical Methods, Detection Limits and Holding Times for Designated-Level Grab Ground Water Samples (continued)

Abbreviations

(*)	Requires 30-day ingrowth-time and 1,000-minute count-time
CLP SOW	Contract Laboratory Program Statement of Work
ea.	each
EPA	United States Environmental Protection Agency
ILM 04.0	Inorganic Laboratory Method 04.0
L	liter
mg/l	milligrams per liter
OLM 04.2	Organic Laboratory Method 04.2
oz	ounce
pCi/l	picoCuries per liter
PCBs	polychlorinated biphenyls
Poly	polyethylene
SOP	Standard Operating Procedure
VOA	volatile organic analysis
µg/l	micrograms per liter

FIGURES

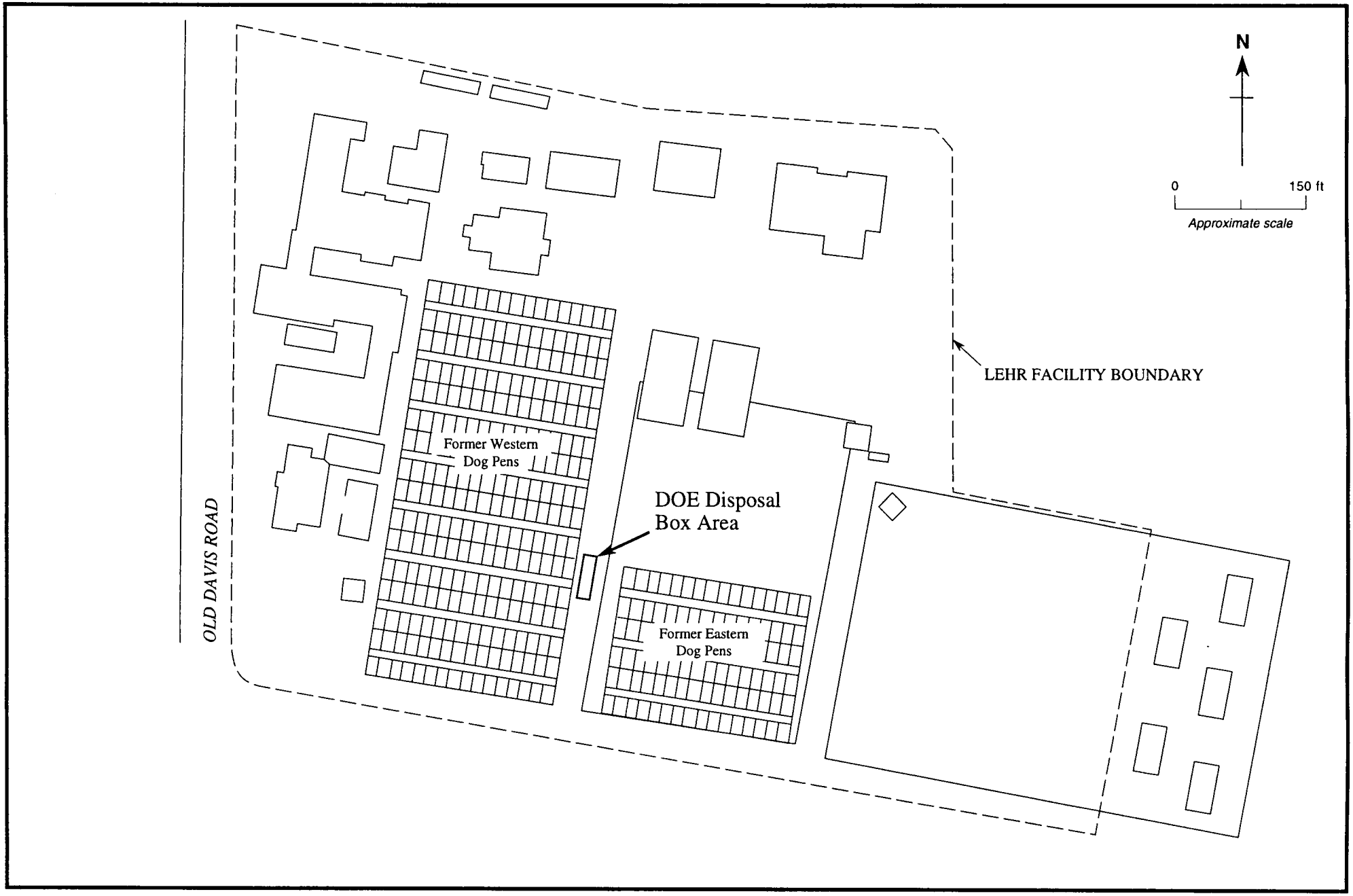

Figure 1. DOE Disposal Box Area Location, LEHR Site, UC Davis, California

4007-540-02.ai

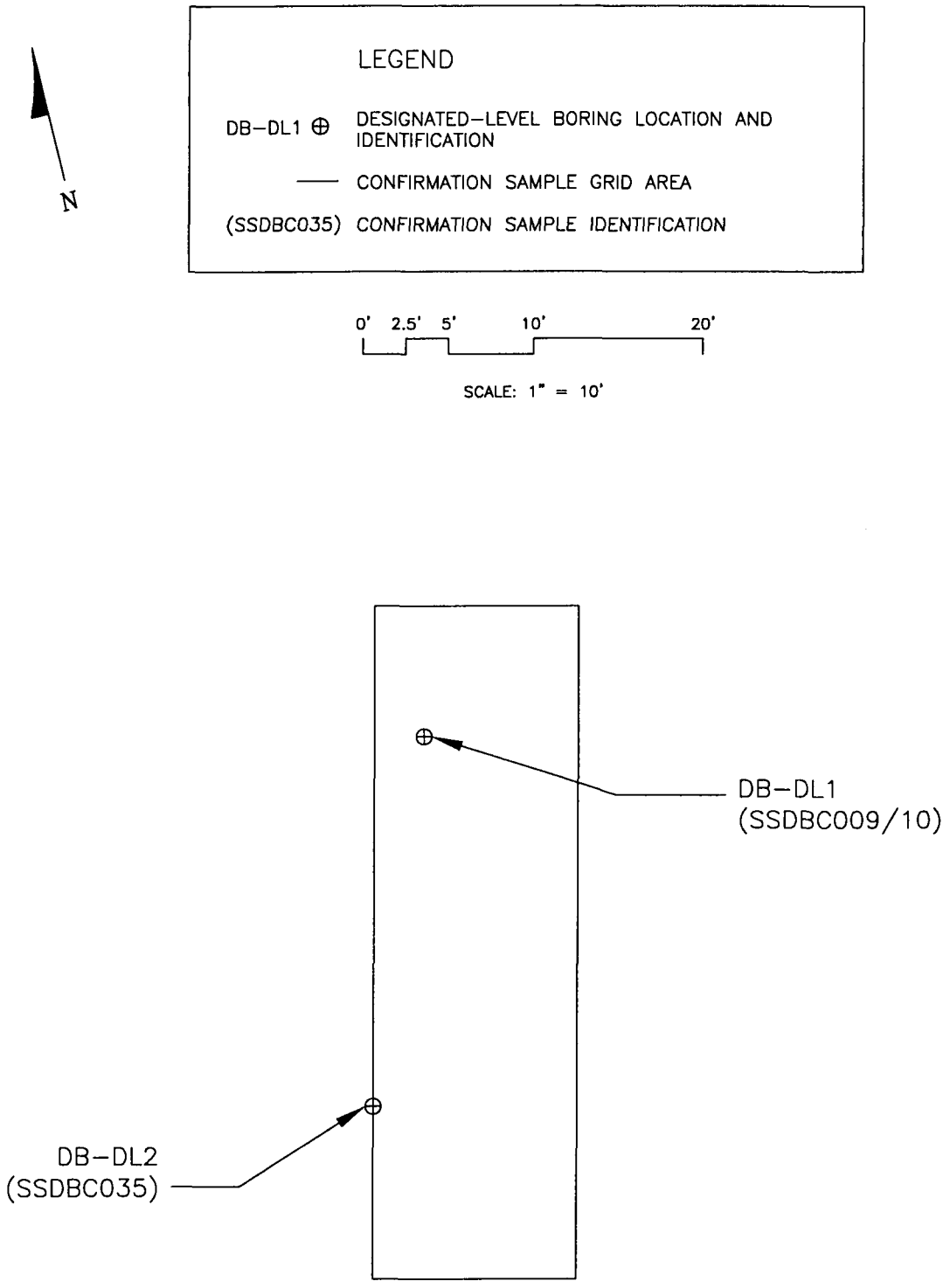

Figure 2. DOE Disposal Box Area Designated-Level Boring Locations

WEISS ASSOCIATES

FILE: L:\LEHR\4007\540\4007-540-02.dwg DATE: 11/04/02 - 10:22am

APPENDIX A

A. PRELIMINARY DOE DISPOSAL BOX AREA DESIGNATED-LEVEL ANALYSIS

A.1 Designated-Level Analysis

The Designated Level Methodology for Waste Classification and Cleanup Level Determination (CRWQCB, 1989) is a guidance document developed by the California Regional Water Quality Control Board, Central Valley Region staff for determining potential to impact ground water from one or more soil constituents.

The Designated-Level (DL) approach consists of three phases:

- Preliminary DL Analysis: Evaluate investigation sampling results and identify DL constituents of concern (COCs) and hot spot areas;
- Data Gaps Investigation: Collect additional vertical profile data if needed for each DL COC at the hot spot area; and,
- Refined DL Analysis: Model and calculate the DL values that protect ground water using the vertical profile of DL COCs.

A.2 Preliminary Designated-Level Data Analysis

The preliminary DL analysis was conducted to evaluate the DOE Disposal Box Area data and identify DL COCs. This sampling and analysis plan is designed to collect additional vertical profile data for the DL COCs. These data will be used to determine if residual concentrations of specific constituents in soil may potentially impact ground water.

A.2.1 Data Management

All of the analytical data from the 2002 DOE Disposal Box data gaps confirmation sampling and 1996 confirmation samples were compiled in electronic form and entered into the LEHR sample database. The complete suite of analyses consisting of 188 analytes was tabulated using the database. The compiled data set was then processed through the screening and evaluation steps described in the following sections.

A.2.2 Preliminary Designated-Level Data Analysis

The preliminary DL analysis consists of four steps described in detail below. Figure A-1 summarizes the preliminary DL analysis process.

A.2.2.1 Step 1—Detected Versus Non-Detected Analytes

After data validation, a table was generated to list all analytes that had been detected in at least one sample. Of the 188 analytes, 149 were not detected in any DOE Disposal Box Area samples. The majority of these analytes were semi-volatile organic compounds (SVOCs), volatile organic compounds (VOCs), and pesticides. Analytes not detected in any sample were removed from further DL evaluation. The detected analytes are shown in Table A-1 by their analytical group and include metals, pesticides, radionuclides, SVOCs, VOCs, and nitrate.

A.2.2.2 Step 2—Background Comparison

The DOE Disposal Box Area samples were collected at greater than four feet (ft) below ground surface (bgs), and were compared to the background data collected greater than four ft bgs.

Step 2 of the preliminary DL data analysis consisted of comparing the magnitude (maximum concentration) of the detected analytes to site background levels. Maximum concentrations of detected analytes were compared to 1.5 times background. This value was selected based on a review of acceptable error margin in analytical measurements which concluded that detection of 1.5 times background is not significantly above background. For organic compounds such as pesticides, SVOCs, and VOCs for which no background data were available, the reported detection limits (RDLs) were used for the comparisons.

The decision to use a factor of 1.5 times the background value when screening maximum concentrations is based on contributions from two forms of error. The first form of error is the acceptable margin of quantitative error allowed in laboratory sample preparation and analysis. The acceptable quantitative error in preparation and analysis of soil samples is ±30% for non-radiological analytes and ±25% for radiological analytes. These error limits are the laboratory control sample recovery limits, which track the combined sample preparation and analysis errors. Analytical errors typically exceed these limits, especially for results reported near the method detection limits, and many of the LEHR-specific background levels are near the method detection limits. The analytical error is taken into account in the screening process, because the maximum concentration is a single laboratory analysis result rather than a value with a high level of statistical confidence.

The second form of error is based on the probability of falsely concluding that a maximum value is representative of contamination. The background value is the 80 % lower confidence limit on the 95th percentile. Because 5% of uncontaminated soil has concentrations above the background value, the maximum concentration will likely be above the background value whether or not the soil is contaminated. The 1.5 factor provides reasonable assurance that carrying naturally occurring maximum values (background concentrations that are above the background value) forward in the screening process occurs with a frequency of less than 20%.

Seven DOE Disposal Box Area analytes were retained for further evaluation in Step 3 (Table A-1).

A.2.2.3 Step 3—Chemical and Physical Properties

Step 3 of the preliminary DL data analysis consisted of comparing the chemical and physical properties that would determine the fate and transport mechanisms of the analytes in the environment and predict their potential impact to the ground water. Specifically, the soil adsorption coefficient (K_d) and the decay half-life of each analyte were used as indicators of the fate and transport in the vadose zone. Table A-1 presents the K_d and half-life values for the analytes retained for Step 3. K_d values were used to evaluate potential impacts of metals, pesticides and VOCs; half-lives were utilized for radionuclides.

K_d values, which represent the relative capacity for a compound to sorb to the surface of a soil particle versus water, were based on data presented in the following references:

- The United States Environmental Protection Agency (US EPA) database entitled "Superfund Chemical Data Matrix" from the US EPA internet website (http://www.epa.gov); and,
- "Soil Screening Guidance for Radionuclides: Technical Background Document," US EPA, EPA/540-R-00-006, October 2000.

The smaller the K_d value, the less sorptive (more mobile) the analyte. In this analysis, the lowest reported K_d value from the literature was selected to be conservative.

During previous site-specific vadose zone Non-Isothermal Unsaturated Flow and Transport modeling, K_d values for specific organic compounds were correlated to the time for the peak concentration to occur at the water table (time-to-peak). A significant correlation was observed during the site-specific modeling, and thus the K_d was selected based on an acceptable time-to-peak for organic compounds. For example, a K_d of 10 milliliters per gram (ml/g) would be equivalent to 2,000 years for the analyte to reach the water table at the peak concentration. A K_d of 1,000 ml/g, corresponds to a time-to-peak of about 100,000 years.

The K_d values for pesticides, SVOCs, and VOCs were compared to a K_d of 10 ml/g. The K_d values for inorganics, such as metals and radionuclides, were compared to a K_d of 1,000 ml/g. The fundamental basis for this screening step is that organic compounds degrade while most inorganic compounds do not. Site vadose zone modeling indicates that a constituent with a K_d of 10 ml/g will reach the ground water table after about 2,000 years. Hence, the screening step eliminates organic compounds with a K_d greater than 10 under the assumption that they will have degraded during the 2,000 year travel time. The K_d screening level for inorganic compounds is set at 1,000 which corresponds to a vadose zone travel time of 100,000 years.

The majority of the analytes evaluated in Step 3 had K_d values less than the screening limits and were potentially less sorptive (more mobile). Detected inorganics and radionuclides have K_d values in the range of 0 to 1,000 ml/g. One radionuclide was screened out of the DOE Disposal Box Area analysis (Table A-1).

The decay half-lives for the radionuclides detected at the site were selected from the following sources:

- The Handbook of Environmental Degradation Rates (Howard, 1991);

- US EPA database titled "Superfund Chemical Data Matrix" from the US EPA internet web site; and ,
- "Soil Screening Guidance for Radionuclides: Technical Background Document" (US EPA, 2000).

A screening criterion of less than one year was chosen for half-life comparison based on the LEHR site waste disposal history. Since land disposal activity at the site ceased at least 20 years ago, and given that the maximum activities of radionuclides at LEHR were on the order of milliCuries, radionuclides with half-lives of one year or less should not significantly impact the ground water.

Half-life values for several radionuclides detected at the site are much less than one year and were therefore eliminated from further evaluation. These radionuclides are typically daughter products (DPs) of other radionuclides and have half-lives on the order of minutes or days. For example, lead-214 and bismuth-214 are DPs of radium, have a 20-minute half-life, and therefore do not pose a risk to the ground water. Table A-1 lists the radionuclides that fail the half-life screening test and were retained for evaluation in Step 4.

A.2.2.4 Step 4—Wilcoxon Rank Sum/Designated-Level/Biodegradability Test

Following Steps 1 through 3, six analytes including hexavalent chromium, nitrate, mercury, molybdenum, americium-241 and uranium-235 were retained for Step 4 analyses (Table A-1). For the Step 4 analyses, the Wilcoxon Rank Sum (WRS) test was performed on the analytes when applicable. In addition, the magnitude and/or frequency of metals and radionuclides were also further scrutinized as discussed below in Section A.2.2.5.

During the preliminary DL analysis, site-specific DLs were not available for the analytes since modeling had not been completed based on area-specific lithology to determine if the analyte would pose a potential risk to the ground water.

The results of the WRS test are summarized in Table A-1. The WRS test statistically measures the relative similarity between the background data set and the environmental sample population, and is used to indicate whether the confirmation data can be represented by the background distribution. To perform this test, at least 40% of the data set should be above the detection limit (US EPA, 1994).

There were a limited number of samples collected at the DOE Disposal Box area. Therefore, the WRS test for uranium-235/236 (U-235/236) was qualified due to insufficient data. The background data sets for molybdenum and americium-241 (Am-241) were at or below the detection limits; therefore, a WRS test was not feasible for these analytes.

A.2.2.5 Analytes Removed After Step 4

One of the five DOE Disposal Box Area analytes was removed from consideration as a potential DL COC after Step 4, as discussed below.

- Am-241— Am-241 was detected above background in only one sample. This sample had a reported laboratory error of over 66% and was qualified for field duplicate imprecision. Therefore, Am-241 was not retained as a DL COC.

A.2.2.6 Analytes Retained After Step 4

Four of five DOE Disposal Box Area analytes were retained as potential DL COCs after Step 4, as discussed below.

- Mercury—This COC was detected above background in 11 of 30 samples at concentrations ranging from 0.25 to 3.9 milligram per kilogram (mg/kg).
- Molybdenum—This COC was detected above background in all ten samples at concentrations ranging from 0.28 to 0.62 mg/kg.
- Hexavalent chromium— This COC was detected above background in all seven samples at concentrations ranging from 0.164 to 0.552 mg/kg.
- U-235/236—U-235/256 was detected above background in four of ten samples at concentrations ranging from 0.0397 to 0.074 picoCuries per gram.

A.3 References

California Regional Water Quality Control Board (CRWQCB), 1989, Designated Level Methodology for waste Classification and Cleanup Level Determination, June.

United States Environmental Protection Agency (US EPA), 1994, Superfund Removal Procedures, Removal Response Reporting: POLREPS and OSC Reports, USEPA Publication 9360.3-03, June.

US EPA, 2000, "Soil Screening Guidance for Radionuclides: Technical Background Document," US EPA, EPA/540-R-00-006, October.

US EPA database entitled "Superfund Chemical Data Matrix" from the US EPA internet website (http://www.epa.gov).

Howard, P., et al. (Howard), 1991, "Handbook of Environmental Degradation Rates," Lewis Publishers Inc., Chelsea, MI.

Table A-1. Preliminary DOE Disposal Box Area Designated-Level Analysis

	Step 1			Step 2			Step 3			Step 4			Conclusion	
Analyte	Units	Sample Count	Number of Detections	Background[1]	Maximum Concentration	Significant Results Above Background[2]	Partitioning Coefficient[3] (K_d) (ml/g)	Radiological Half-Life (years)	Is Kd < Limit[3] and Half-Life > 1 year	Is WRS Test Applicable?	WRS Test Result	Is Analyte Biologically Recalcitrant?	Is Constituent a DL COC?	Explanation
General Chemistry														
Chromium, Hexavalent	mg/kg	7	7	0.054	0.552	Yes	1.90E+01	NA	Yes	No	NA	Yes	Yes	Requires additional sampling/evaluation
Nitrate	mg/kg	31	31	36	58.7	Yes	0	NA	Yes	Yes	Pass			
Metals														
Arsenic	mg/kg	10	10	10.9	8.2	No								
Barium	mg/kg	10	10	294	231	No								
Beryllium	mg/kg	10	10	0.924	0.59	No								
Chromium	mg/kg	30	30	125	140	No								
Cobalt	mg/kg	10	10	31	24.3	No								
Copper	mg/kg	10	10	61.8	48.9	No								
Iron	mg/kg	10	10	44000	40500	No								
Lead	mg/kg	10	10	9.5	9.2	No								
Manganese	mg/kg	10	10	750	800	No								
Mercury	mg/kg	30	30	0.248	3.9	Yes	5.20E+01	NA	Yes	Yes	Fail[4]	Yes	Yes	Requires additional sampling/evaluation
Molybdenum	mg/kg	10	10	0.26	0.62	Yes	2.00E+01	NA	Yes	No	NA	Yes	Yes	Requires additional sampling/evaluation
Nickel	mg/kg	10	10	246	241	No								
Selenium	mg/kg	10	10	1.2	1.5	No								
Vanadium	mg/kg	10	10	80.3	73.1	No								
Zinc	mg/kg	10	10	93.1	85.1	No								
Radionuclides														
Actinium-228	pCi/g	19	19	0.642	0.7	No								
Americium-241	pCi/g	10	4	0.014	0.033	Yes	8.80E+02	4.33E+02	Yes	No	NA	Yes	No	Only one sample is above background. This sample had a reported laboratory error of 66% and was qualified for field duplicate imprecision.
Bismuth-212	pCi/g	19	14	0.434	0.57	No								
Bismuth-214	pCi/g	19	19	0.54	0.74	No								
Carbon-14	pCi/g	19	1	0.13	0.175	No								
Lead-210	pCi/g	19	5	1.6	0.515	No								
Lead-212	pCi/g	19	19	0.684	0.76	No								
Lead-214	pCi/g	19	19	0.581	0.75	No								
Plutonium-241	pCi/g	10	3	0.5	1.07	Yes	1.00E+03	1.44E+01	No					
Potassium-40	pCi/g	19	19	14	12.8	No								
Radium-226	pCi/g	19	19	0.752	1.13	No								
Radium-228	pCi/g	10	10	0.655	0.632	No								
Strontium-90	pCi/g	19	7	0.056	0.0721	No								
Thallium-208	pCi/g	19	19	0.223	0.224	No								
Thorium-228	pCi/g	10	10	0.771	0.768	No								
Thorium-230	pCi/g	10	10	1.04	0.755	No								
Thorium-232	pCi/g	10	10	0.8	0.82	No								

Table A-1. Preliminary DOE Disposal Box Area Designated Level Analysis (continued)

	Step 1			Step 2			Step 3			Step 4			Conclusion	
Analyte	Units	Sample Count	Number of Detections	Background[1]	Maximum Concentration	Significant Results Above Background[2]	Partitioning Coefficient[3] (K_d) (ml/g)	Radiological Half-Life (years)	Is Kd < Limit[3] and Half-Life > 1 year	Is WRS Test Applicable?	WRS Test Result	Is Analyte Biologically Recalcitrant?	Is Constituent a DL COC?	Explanation
Radionuclides														
Thorium-234	pCi/g	19	9	0.78	1.13	No								
Tritium	pCi/g	19	1	1.2	1.4	No								
Uranium-233/234	pCi/g	10	10	0.706	0.551	No								
Uranium-235/236	pCi/g	10	10	0.038	0.074	Yes	10	7.04E+08	Yes	Yes	Fail[4]	Yes	Yes	Requires additional sampling/evaluation
Uranium-238	pCi/g	10	10	0.645	0.583	No								

Notes

[1]Established background value for naturally occurring analytes in soil located more than 4 feet below ground surface.

[2]Results are considered significant enough to require further screening if maximum concentration is greater than 1.5 times background and more than 5% of the data are above background.

[3]Limit K_d is 1,000 ml/g for inorganic compounds and 10 ml/g for organic compounds.

[4]Insufficient data were available to demonstrate allowable decision error in WRS test results.

Abbreviations

COC	constituent of concern
DL	designated-level
K_d	soil adsorption coefficient
mg/kg	milligrams per kilogram
ml/g	milliliters per gram
NA	not applicable
pCi/g	picoCuries per gram
WRS	wilcoxon rank sum

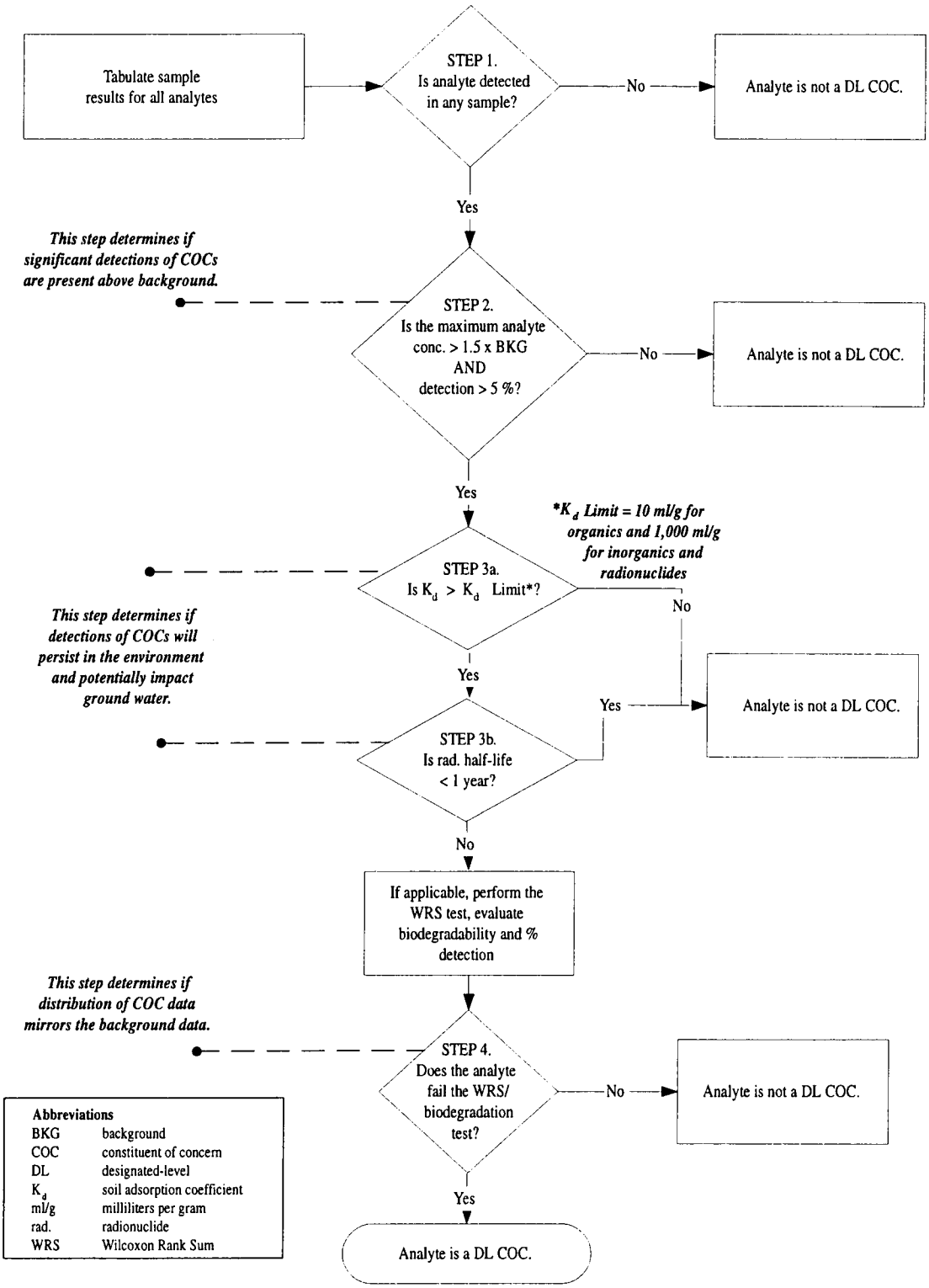

Figure A-1. Preliminary Designated-Level Analysis Flow Chart

Weiss Associates